any nebula in the catalog position of N. G. C. 6610 as bright as the 17th or 18th photographic magnitude. Either the N. G. C. position is in error or the nebula is variable. A mistake of 10^s in right ascension would probably identify N. G. C. 6610 with the object on the Mount Wilson plate, but in this case we should certainly have a case of variability. The object photographed here shows the graded intensity and the granular or mottled structure which is characteristic of many small nebulæ and fits the N. G. C. description of No. 6610 well enough, but it would be rash to say that it is not a photographic defect. Its position for 1875 is

$$18^h\ 11^m\ 26^s + 14^\circ\ 57'.2$$

In the meantime, it is clear enough that N. G. C. 6610 is subject to the uncertainty mentioned above.

FREDERICK H. SEARES.

COLOR-PHOTOGRAPHS OF NEBULÆ.

Color-sensitive plates and special ray-filters have been used on one or two occasions to test the homogeneity of radiation from different parts of a nebula. Keeler, for example, compared ordinary photographs of the *Orion* nebula with others on isochromatic plates exposed behind a yellow screen, and was thus able to confirm Campbell's visual observations of variations in the relative intensity of the spectrum lines. In 1905, Hartmann, with filters of more restricted transmissibility, showed that the great photographic activity noted by Keeler in certain regions was to be attributed to the unusual intensity of the line $\lambda 3727$. Again a red-sensitive plate and a filter transmitting nothing to the violet of $\lambda 5700$ enabled Mr. Hale to demonstrate the reality of the reddish fringe observed by Barnard, and later by Keeler, along the southern boundary of the Huyghenian Region, and to show that it was probably due to a local intensification of the $H\alpha$ line of hydrogen.

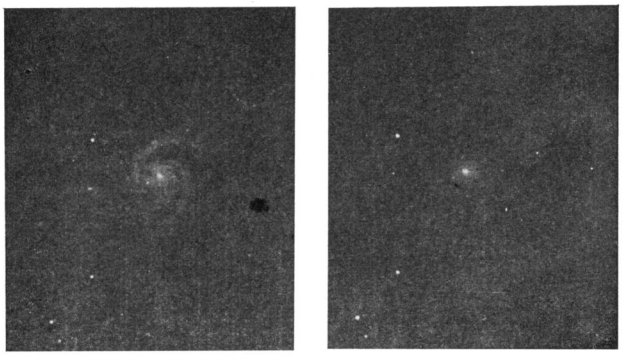
It seems not unlikely that the principle involved in these experiments can be made the basis of an analytical method of considerable usefulness. Photographs thus obtained show admirably, but without differentiation, the distribution of whatever luminosity lies within the limiting wave-lengths defined by the color sensibility of the plate and the transmissibility of the filter. By proper adjustment of plate and filter the photographs can be made nearly monochromatic, and we approach the method of spectrum analysis, but with the added advantage of a record of the distribution of luminosity. But if we approach monochromatic radiation too closely we encounter the difficulty which so generally limits observation with the spectrograph—the exposures become excessively long if not impossible. On the other hand, a step in the opposite direction means a sacrifice in the refinement of analysis. Experience only can determine the nature of the compromise which must here be effected.

In the meantime, preliminary experiments with ordinary and isochromatic plates, the latter used with a yellow filter transmitting to the red of λ4900, have given some interesting results which are briefly described below. All of the photographs have been made with the 60-inch reflector. The exposures for the isochromatic plates were from four to six times those for the ordinary plates, this ratio giving comparable images for the bluest stars. For brevity the two kinds of plates will be referred to as "yellow" and "violet," respectively.

Altho the yellow filter begins to transmit at about λ4900, the sensibility curve of the plate-and-filter combination is very flat in this region and does not rise to any considerable extent until λ5000 has been passed. In consequence, neither of the nebular lines N_1 and N_2 is transmitted with appreciable intensity; the yellow photographs, when strong, are therefore a record of the luminosity distribution for radiation lying well to the red of the chief nebular line. The red limit of the combination is λ5900. The sensitiveness of the ordinary plates, on the other hand, extends to λ5200 or even λ5300, so that the violet photographs include the effect of the characteristic nebular lines.

Planetary Nebulæ N. G. C. 2893 and 3242. Both objects contain star-like nuclei surrounded by nebulosity, but with marked differences in structure. A factor of four to one in the exposure times gives closely comparable yellow and violet images, for the nebulosity as well as the nuclei. Little or no difference in distribution is noticeable, and both objects are relatively rich in yellow light.

Ring Nebula in Lyra. The great photographic activity of this object has long been known, but it was a surprise to find that a quarter of an hour was required to record on a yellow plate as much as was obtained on the violet in 15^{s}. The only comparable images at present available are faint. They show little if any difference in the color of the ring and the central star. Both are intensely blue or violet. As the exposure factor is eight or ten times that necessary for comparable images of an A_0 star, the color-index of the central star must be of the order of —1.5 or —2.0 magnitudes.



A B

DISTRIBUTION OF VIOLET AND YELLOW LIGHT IN MESSIER 99*
A. Seed 27, Exposure 10^{m}. Violet Light.
B. Cramer Iso, Exposure 60^{m}. Yellow Light.

The Spiral Nebulæ Messier 51, 94 and 99. Here we have the most interesting results thus far obtained. The nuclei in all three cases are of great relative intensity on the yellow

*The original photographs show much detail that is lost in the reproduction.

plates. Rough estimates of their color-indices are in accordance with the advanced spectral types which characterize the central portions of spiral nebulæ. The center of the great condensation at the extremity of the branch on the northern side of M 51 is also very yellow; but the minor condensations scattered along the branches of all three spirals are in many instances so deficient in yellow luminosity that they do not appear at all on the yellow plates or are lost on the background of faint nebulosity, which in places is of much the same intensity on both violet and yellow plates. The branches as a whole are relatively blue, but in many of the star-like condensations the more refrangible radiation is relatively very intense.

In comparisons of the sort described, care must be taken to allow for differences in gradation on the two kinds of plates. This difference is frequently important, but for the plates in question the variation in the distribution of the luminosity is so pronounced that there is no mistaking the phenomenon.

FREDERICK H. SEARES.

SIX CEPHEIDS WITH VARIABLE SPECTRA.

Variations in the spectra of eleven Cepheid variables have been announced in recent communications.[1] A considerable number of spectrograms of these stars has been secured during the last two months, and in all cases the variations previously reported are confirmed. Several other Cepheids have been added to the observing program, in fact, all of the brighter ones; and to the list of known spectrum variables six more stars may now be added. In the following table the brightness at maximum and the range of variation are given in visual magnitudes. The photographic range has been measured for some of these stars and found to be nearly double the visual change. The total range of spectrum variation is probably larger in many cases than defined by the limits here given, as the plates are made without knowledge

[1] *Proceedings of the National Academy of Sciences*, **2**, 132, 136, 208, 1916.